

## An overview on Growth and Development of Agar Plant (*Aquilaria malaccensis* Roxb) Through Management Practices in Bangladesh

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### ABSTRACT

The study was undertaken to the growth and development of agar plant through management practices. Bangladesh is favorable for Agar plant production commercially. The history of agar in Bangladesh is very ancient and grows naturally in Sythet, Chittagong, Cox's Bazar and Chittagong hill tracts from time immemorial but at present natural grown agar tree is very hard to find. Agar is one of the most promising non-timber forest products (NTFPs) of Bangladesh. The atmospheric and soil condition of Sylhet Region are also congenial for the growth and development of Agar wood. Very little information is available on cultivation practices of Agar plant. Research and development may create an ample scope of boost up its production, particularly in south-east hilly regions in the country. A rigorous research is needed for development of agar enterprise and increase systems productivity with intercropping of other plants or crops. There is a pressing need to document and identify the species of agar trees are being cultivated by the farmers. There are potential opportunities that would arise in the future for improving the livelihoods of poor people in the region by providing income generating means.

**Keywords:** Agar plant, Growth, Agro forestry, Management practices, *Aquilaria malaccensis*

### INTRODUCTION

‘Agarwood’ or ‘eaglewood’ an occasional product of genera *Aquilaria* and *Gyrinops* in the plant family Thymelaeaceae is the most expensive wood in the world. IUCN-The World Conservation Union Red list categories of six species are considered at risk from over-exploitation for agar wood. According to convention on International Trade in Endangered species of wild Fauna and Flora (CITES), *Aquilariamalaccensis* rated vulnerable and *A. crassna* is "critically endangered" while there seems to be some confusion over *A. agallocha*.

This species is considered a synonym for *Aquilaria. Malaccensis* [1, 2,3] although some believe *A. agallocha* to be distinct species. The species, which attains a height of about 40 m, is tropical evergreen in nature and sometimes is also named as *A. malaccensis*[4.5.6]. Agar plant prefers high humid, sub-tropical climate with rainfall 1800-3500 mm per annum. It grows from sea level upto 500-m altitudes. It is a sun-loving plant and requires lot of sunshine. It prefers well-drained deep sandy loam-to loam rich in organic matter but can profitably be

grown in marginal soils and also in shallow soils over rocky beds with cracks and crevices. It grows well in hill slopes and forest. The traditional agar growing areas show that it prefers acidic soil reaction. The mycorrhiza and other beneficial fungi which seems to be responsible for oil formation in the agar tree being soil borne requires acid soil for building up their population. Agar is a long-term plantation crop. A profitable plantation may be of 15 years cycle or more. Normal management short cycle plantation yields only essential oil or ‘agar attar’ of low quality (Boya oil). Agar trees are grown in their homestead in combination with other trees. Agar is one of the most promising non-timber forest products (NTFPs) in the World. Akter et al.[7] reviewed that artificial induction is not a new story but yet to be made known and available in the country. Chowdhury et al.[8] reported that it would be preferable to consider artificial inoculation to get better quality and yield, and to change the economic standards of agar cultivators of Bangladesh. Chowdhury [9] evaluated a novel technique, called the aeration method, for producing agarwood in cultivated

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*Aquilaria* trees. Hayder et al. [6] reported that agar is one of the most promising non-timber forest products (NTFPs) of Bangladesh. Rahman et al. [10] reported that the population of agar tree is rapidly declining in natural forests in Bangladesh, and the species is now being planted in government-owned degraded forest sites as well as privately owned homestead forests.

They also found that the traditional management practices were adapted mostly based on indigenous knowledge and technology to manage agar plantations. The aim of the study is to explore the growth and development of agar plant through management practices.

### METHODOLOGY

Literatures were identified for review through a comprehensive search by using electronic and non-electronic databases. The study used secondary data that have been collected from a review of the existing journal literature; books, report, blogs and newspaper were carried out. Related published literature and documents were searched in a systematic way using a range of key words relating to Agar plant, *Aquilaria malaccensis* and growth in the google, google scholar and web of science database. Information was also collected from GO and NGO's by personal communication.

### Agar Plants cultivation of Bangladesh

*Aquilaria malaccensis* produces seeds after 7-9 years while some other species produce seeds only once in their life cycle. Seed viability is approximately 1 week and germination takes place between 16–63 days [11]. Germination is epigeal and of the hypogeal type. Germination

rates may reach 90% for mature fruits that are sown immediately (Chang, pers. comm.). Trial planting on the grounds of the Forest Research Institute Malaysia had shown that survival of tissue-cultured plantlets 24 months after planting was 66.3% while that of seedlings was 40.3%. The initial and final plantlet heights were 43.1 and 136.6 cm, respectively, while those for the seedlings were 27.9 and 114.8 cm, respectively [12].

The mean diameter at breast height (dbh) of the stand was 38.2 cm during cultivation of 1928 to 1995 with a mean height of 26.7 m and a mean clear bole height of 15.7 m in Malaysia [13]. Bangladesh can earn more than Tk 100 crore annually by developing its agarwood sector and exporting agar products abroad, according to officials of Bangladesh Forest Research Institute (BFRI), reports UNB (The Independent, 20 April 2016).

BFRI also reported only *Aquilaria malaccensis* is cultivated in Bangladesh. Akter and Neelim [14] analyzed the agarwood plantation at a BRAC tea estate. They first point out that given the typically high value of agarwood, excessive harvesting had made this species threatened. Hence, BRAC had started agarwood plantation at Kaiyachar tea estate in July 2007, with a plantation of about 17 acres, where 83,400 agar seedlings had been planted between August and October 2007.

In addition, 700,000 agar seedlings had been planted in two nurseries of the tea estate. The survival rate of young seedlings was an impressive 95 percent, and hence, the BRAC tea estate now plans to plant 50 acres of land with agar plant.

**Table 1.** Area under agar cultivation at different regions of Bangladesh

Location	Area (ha)	Managing entities	Plantation period	Reference
Kaiyachara Tea Estate, Fatikchari	6.9	The Bangladesh Rural Advanced Committee (BRAC)	July, 2007	Akter and Neelim [14]
Karnafuli tea estate	0.6	BRAC	2004	Akter and Neelim [14]
Buffer zone of the Kaptai National Park	283.0	Participants of social forestry programe	2007-2012	Rahman [15]
Charaljani and Keochia research stations in Chittagong	2.3	Bangladesh Forest Research Institution (BFRI)	-	Rahman <i>et al.</i> [16]
Government agar garden in Denuded forest areas of Sylhet, Chittagong and CHTs	1217.0	Forest Department (FD)	1999-2011	Novel [17]
121 Privately owned agar garden in Sylhet Division	>1500.0	Private owner	1999-2011	Novel [17]

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### Propagation

Agar is propagated by seeds, which are available in the month of June-July. The germination of seed is epigeal, therefore, special care should be taken in nursery management. They are first germinated in sand beds and then transferred to poly bags. Seed has short viability period (7-10 days) [18].

Successful seed storage is difficult and loss of viability occurs very quickly once seeds are exposed to the environment. However, with good planning, proper management and modern nursery practices, *Aquilaria* seedlings can be produced in large numbers [19].

**Table2.** Suitable climatic and soil factors for the cultivation of *Aquilaria* species

Climatic variables and soil factors	Range of values
Altitude range	29 - 1000 m
Annual rainfall	1500 - 6500 mm
Annual temperature	22 - 28°C
Maximum temperature of hottest month	22 - 40°C
Minimum temperature of coldest month	14 - 22°C
Absolute minimum temperature	5°C
Soil texture	light; medium
Soil drainage	Free
Soil reaction	acid; neutral
Special soil tolerances	shallow; other

**Source:** Adopted from [21]

### Transplanted In Poly Bags

From 25 days onward when the cotyledons just drops down, the seedlings are transplanted carefully to poly bags arranged under temporary shade. Normal management practices should be adopted. After planting young seedlings in poly bags, they are arranged in bed supported by bamboo poles around.

At monthly interval the shifting of bags should be done to prevent the penetration of roots into the soil. Shifting of seedlings should be followed by light watering to avoid wilting due to disturbances in the root system. Root trainer may be used successfully [18].

### Field Layout

Agar is a long-term plantation crop. A profitable plantation may be of 15 years cycle or more. The short cycle plantation yields only essential oil or 'agar attar' of low quality (Boyaoil). Bangladesh Forest Research Institute (BFRI) also developed the nursery and plant management techniques for agar plant. They suggested the suitable seed sowing time is June to July. Generally agar plant should be planted at a spacing of 2.75 m × 2.75 m in commercial

### Soil and Environmental Suitability for Agar Cultivation

*Aquilaria* species grows naturally in all ecological zones and on a variety of soils under wide climatic condition (Table 2), including those that are rocky, sandy or calcareous, well-drained slopes and ridges and land near swamps. However, significant mortality rate were reported 3-4 years after plantation in Kaiyachara Tea Estate, Fatikchari seemingly due to water logging [14]. *Aquilaria* is first growing trees and in areas with adequate moisture, can achieve 10 cm DBH in 4 to 6 years [19]. Planting on sloping land is thus recommended for agar [20].

plantation, but in home gardens it may be 1 m × 1 m to 1.5 m × 1.5 m spacing [22]. The plantation may be planned in two ways: (a) planting at wider spacing along with some suitable intercrops and harvesting at the end of the crop cycle. (b) Planting at comparatively closure spacing and harvested at 2-3 phases. In the second approach about 8-10 years of planting about 40 % selected trees may be harvested with a view to thin out the plantation for better growth and development of the remaining trees and also to get a substantial income [18].

### Plantation

Planting should be done when the plants have the greatest chances of survival. The best time is during the rainy season (May-September). Under average condition spacing ranges between 2.5-5 m, (initially accommodating about 1700 plants per hectare) which at later stages i.e., after 8-10 years of growth maintained at 4-5 m by harvesting in phase manner. When the planting is raised with some other forest species the spacing may be given accordingly. The distance for avenues and public places depends upon the situations and purpose of planting which may

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range between 3-4 m. Planting of the saplings is done in well-prepared pits of size 50 × 50 × 50 cm made in advance and preferably in the evening time or during the cloudy weather. After planting staking should be done to keep the seedling in upright position and the soil around the plant should be firmly consolidated. Immediately after planting, watering is necessary. In no case, the soil around the root be disturbed or removed during planting [19]. Agar trees require 2 × 2 m spacing for rapid growth and development [23].

### Manuring

It is not necessary to apply inorganic fertilizers at the time of planting. Fertilizers should be applied after complete establishment and only from second year of planting. Well-decomposed cowdung/FYM @ 10-15 kg/pit of size 50 cm<sup>3</sup> may be applied in pit and well mixed with soil prior to planting. Undecomposed FYM or fresh cow dung should not be applied in any case. The rhizosphere of Agar tree (0-45 cm) exhibits a higher rate of microbial population when organic manures are used [18].

### Fertilizer Application

Nitrogen (N), P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O at 10:10:4 ratio as per the following schedule may be applied from second year onward preferably in two splits- Second year- 200 g/tree, Third year- 300 g/tree, Fourth year onward- 500 g/tree. The fertilizers should be applied along with decomposed cow dung/compost @10-15 kg/tree. In the virgin forestland initially no fertilization is required. Later depending on crop growth fertilization may be resumed accordingly. From 6-7 years of growth nitrogenous fertilizer @ 400-500 g/tree per year may be applied in two splits during pre and post monsoon period. This may help in keeping the tree wood soft, with higher content of cell sap enabling easy insect boring followed by fungal infection and spread of infected area over a larger wood volume i.e., higher rate of bioconversion [18].

### Cultural Operation

Soil working to a radius of 50 cm is to be done once in 3-4 months. Fertilizer application should also be followed by these operations preferably twice in a year, before and after monsoon from second year onwards. Agar seedlings are foraged by goats or cattle. To protect plantation, fencing is necessary. Initial 4-5 years period should be protected from farm animals. Trenching around the plantation has also given good

success. All the replacements of casualties should be done in the same planting season and if necessary second replacement may be done during the second year using large size seedlings [18].

### Technique Use on Agar Plant

Agarwood induction, as perceived by local people, on trees growing in the natural environment, happened in old trees that had been stroked by lightning or attacked by animals, insects, or microbes. The formation is usually in proximity to wounded or decaying parts of the trunk. Initially it was thought that formation of agarwood takes place only in the stem or the main branches.

It happens in roots and twigs as well. Various conventional methods have been developed e.g., Nailing Method, Drilling method, Partly-Trunk-Pruning Method (PTP), Burning-Chisel-Drilling Method (BCD), Fungi-Inoculation Method (FI)etc and Modern artificial wounding technique like Aeration Method, Whole-tree agarwood inducing technique (Agar-Wit), Cultivated agarwood kits (CA-Kits)etc are absent in the Bangladesh. These methods are hand-down traditions and have been practiced sustainably on trees growing on individual and ancestral lands and in natural forests [21].

### Intercropping

Vegetables/pulses or aromatic crops like Patchouli (*Pogostemoncablin*), Sugandhmantri may be cultivated as short season/short term intercrops during first three to five years of plantation. In the later stages shade loving medicinal plants like Sarpagandha (*Rouvol fiaserpentina*), long pepper (*Piper longum*) may also be grown for another few years depending on plant population and land type. Ginger/Turmeric may also be planted leaving about 50 cm around plant base. Both the crops are exhaustive in nature for which some special care has to be taken. This type of crops should not be taken more than two seasons. Agar can also be intercropped with Acacia, upland rice and pineapple.

Some farms in Vietnam also integrate agarwood and fruit trees in their home gardens. It can be intercropped with a combination of agricultural crops and fruit trees such as upland rice, cassava, beans, sweet potato, yam, banana, pineapple, jackfruit and many more. Saikia and Khan [24] reported that low input needs and flexibility in site requirements as well as

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suitability for intercropping make agar a preferred cash crop in the home gardens of upper Assam. They showed that agar based home gardens in upper Assam are financially rewarding and can generate significant amount of money for sustaining the economy of the region.

### Coppicing Ability of the Tree

Agar tree regenerates freely. This characteristic facilitates (1) harvesting of infected tree leaving the tree trunk for quick regeneration for a second crop and (2) seed production from the coppiced tree once identified as a good mother plant from quality and production point of view. Coppicing during 10-15 years ago, the growth of new shoots is at a faster rate and attain harvestable within next 10-15 years with comparatively higher yield of distillable wood. A second coppicing depends on the condition of the growing environment and root system. Higher infestation of woodborer and fungal infection are also observed compared to normal tree. Best results are obtained during March-May. Coppicing during monsoon and also during winter months gives poor results [18].

### Agar in Agro-Forestry

Agar tree is suitable for growing on field boundaries and for dividing whole plot into sub-plots. Not only this, agar tree is also grown on borders of gardens, school compounds, office compounds, parks and residential sites. The good capacity for pollarding and coppicing has made it suitable to fit in agro-forestry. The canopy of Agar tree is such that it allows sunshine penetration partly. Thus, it can be planted in field boundaries, bunds etc., without affecting the field crops.

Besides, agar tree has been successfully grown for strip planting along banks of ponds, tanks, canals and roads. In hilly areas / tillasas in Barak valley it can be planted on poor soils on hill slopes, tillatops. They help in reducing soil erosion and land sliding caused by rushing water during rainy season. Agar tree could successfully be introduced in Social Forestry and also in afforestation programmer [18].

### Agar in Tea Garden

Tea growing situation is also ideal for agar tree. The increasing demand of agarwood, it is being introducing as shade tree in tea plantation particularly in Upper Assam with success. Agar tree is evergreen and with spreading canopy it allows partial penetration of sunshine through it.

Regular looping of branches above tea bushes is necessary [19].

## CONCLUSION

Bangladesh is favorable for Agar plant production commercially. The hilly barren area of the country could be transferred to goldmine. There is no systematic research and well documented information about agar plant species used for oil production and developed technology related to plant production and processing in Bangladesh. The agar wood production could be a multifaceted field of prospects in Bangladesh. There are major challenges to date which includes scarcity of high quality seedlings, lack of modern management practices and absence of modern artificial wounding technique. Artificial induction is not a new story but yet to be made known and available in the country. This is the time to think about investing on research of induction to achieve economic goal of plantation. They concluded that there appeared to be a sustainable source of raw materials, and that with the availability of technical and financial assistance and an opportunity for expansion of market facilities the maximum benefit from this highly promising industry could be secured.

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